

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

High Efficiency
Engines and Turbines

12/2002



ROTATING HEAT TRANSFER IN HIGH ASPECT RATIO RECTANGULAR COOLING PASSAGES WITH SHAPED TURBULATORS

Description

PRIMARY PARTNER

Texas A&M University

TOTAL ESTIMATED COST

\$ 189,248

CUSTOMER SERVICE

800-553-7681

STRATEGIC CENTER FOR NATURAL GAS WEBSITE

www.netl.doe.gov/scng

Under the Advanced Gas Turbine Systems Research (AGTSR) program, Texas A&M is conducting stationary and rotating experiments and computations to provide turbine engineers with new data for design of airfoil internal rectangular cooling passages. Figure 1 illustrates the complexity of design for internal cooling of turbine airfoils. Part I experiments are conducted for two channel aspect ratios and with smooth channels and with three types of turbulators (turbulence promoters) to enhance cooling effectiveness. Rotation number, Reynolds number, and angular orientation of the channels with respect to the rotation axis are varied. Average heat transfer coefficients and pressure drops are measured at locations along the cooling passages. The resulting new heat transfer and pressure drop data are correlated and compared with numerical predictions in Part II. Using the experimental data from Part I, the performance of a RANS code and a state-of-the-art Reynolds stress turbulence model are validated in Part II for predicting cooling channel flow and heat transfer characteristics. The verified codes are then used to predict flows and heat transfer characteristics in cooling channels with a very high Reynolds number (500,000) and buoyancy parameter (10).

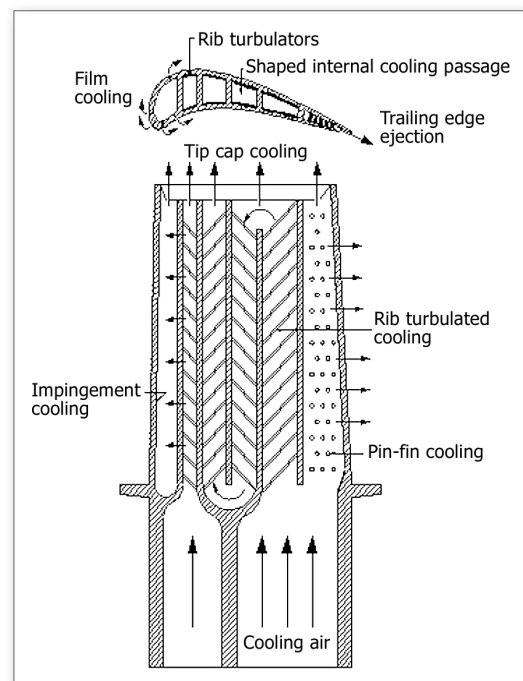


Figure 1. Cooling channels within turbine blades



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Duration

24 months

Goals

Effective internal cooling of airfoils is needed to minimize cooling penalties on turbine power and efficiency. The cooling effectiveness of airflow through internal rectangular channels in rotating blades is different from that for stationary airfoils due to rotation induced secondary flows. Cooling effectiveness is also enhanced by turbulators within the cooling channels. This project investigates the effects on rotating blade cooling performance of various rectangular cooling passage designs representing a range of aspect ratios, turbulator configurations, Reynolds numbers, coolant-to-wall temperature ratios, rotation numbers, buoyancy parameters, and orientations of the channel with respect to the rotation axis.

Benefits

This project will provide turbine designers with new internal cooling data for improving the performance and thermal efficiency of turbine engines.